FreedomCAR Technology

Advanced Technologies Fuel FreedomCAR Development Efforts

Reducing our dependence on petroleum while preserving freedom of choice and affordability will require new approaches to vehicle design and technology. The FreedomCAR Partnership is all about facilitating beneficial relationships between government and industry partners who are working together to find new solutions to our nation's transportation challenges. By spreading the cost and risk of innovation across multiple organizations, FreedomCAR will speed introduction of new concepts to the marketplace.

FreedomCAR partnerships seek to move technology beyond the current market situation, in which a limited number of internal combustion-hybrid electric vehicles are available, to future mass commercialization of advanced energy efficient vehicles including those incorporating fuel cell engines together with hybrid electric drivetrains. Here are some of the specific goals of current FreedomCAR technology research:

Reducing Vehicle Weight

Lighter cars use less energy. The challenge is to reduce vehicle weight without compromising occupant safety or engine durability. Advanced plastics, ceramics, and metal composites will be among the materials that help achieve the FreedomCAR goal of vehicles that are 50% lighter than today's cars. Many of these materials will incorporate recyclable and renewable products that further enhance the vehicles' environmental friendliness.

Examples of promising technologies to reduce vehicle weight include:

- New carbon-fiber composites that could reduce vehicle body and chassis weight by more than 60%
- Continuously cast and hot-rolled aluminum alloys that can be used to fabricate lightweight body and chassis components
- Advanced materials and coatings capable of handling the higher temperatures created in small engines

Improving Energy Production and Storage

Batteries and gas tanks are the primary energy storage devices in today's vehicles. As we move toward cars that depend more on electricity and hydrogen, the focus will be shifting to development of new, safe, and efficient energy storage devices that allow reasonable driving range and accessory support.

Examples of promising energy storage technologies include:

- Safe nickel-metal hydride (NiMH) and lithium-ion (Li-ion) batteries that combine high energy density and longer life
- Compact fuel processors for onboard hydrogen generation
- Ultracapacitors that offer up to 100 times the energy of conventional capacitors and deliver 10 times the power of ordinary batteries

Advancing the Internal Combustion Engine

New-technology vehicles are evolving from the traditional internal combustion vehicles that we have relied upon over the last century. Internal combustion is not going away, because some applications demand the power that only internal combustion can provide within reasonable size constraints. In many cases, though, the internal combustion engine's role is changing to one of a supporting player, providing extra power when needed for acceleration rather than a steady source of motoring power, as is the case with some of today's commercially available hybrid electric vehicle designs. This supporting role calls for a smaller, lighter internal combustion engine that will free up room for other engine components.

Examples of promising internal combustion engine technologies include:

- Compression-ignition direct-injection (CIDI) diesel engines that have the highest thermal efficiency of any internal combustion engine
- Spark-ignition direct-injection (SIDI) engines that offer improved thermal efficiency, better response, and greater displacement-specific power
- Variable-compression-ratio (VCR) technology with super-charging that may significantly improve spark-ignition engine efficiency without compromising proven emissions control technology
- Homogeneous-charge compression-ignition (HCCI) engines that promise high efficiency, very low emissions of oxides of nitrogen (NOx) and particulates, and relatively low cost

Building Electronic Components to Control the Car of the Future

Just as today's cars have computers to control engine operation, tomorrow's cars will depend on even more on sophisticated electronics to coordinate a complex system of engine operation, fuel delivery, and power delivery for maximum efficiency.

Examples of promising electronic component technologies include:

- Low-cost integrated power electronic modules capable of handling up to approximately 100 kW of power for vehicle operation within necessary size and weight parameters
- Onboard sensors that directly observe and report on engine performance factors
- Ion mobility sensors that help raise fuel efficiency, reduce pollutants, and increase the reliability of catalytic converters

Developing Robust Hybrid Electric Drivetrains

Hybrid electric drivetrains will play an increasingly significant role in the car of the future. These are available now in smaller passenger vehicles, and some elements of today's HEVs will almost certainly be present in future vehicles as well. The key to developing successful hybrid electric drivetrains is finding a balance between size, weight, power, and energy requirements.

Examples of promising hybrid electric drivetrain technologies include:

- Series hybrids, in which the electric engine is the only source of wheel power, and the generator is powered by the fuel engine
- Parallel hybrids, in which the fuel engine is typically the main source of wheel power and battery charging, but both provide power to the wheels
- Advanced thermal management that improves climate control and energy efficiency without compromising vehicle performance